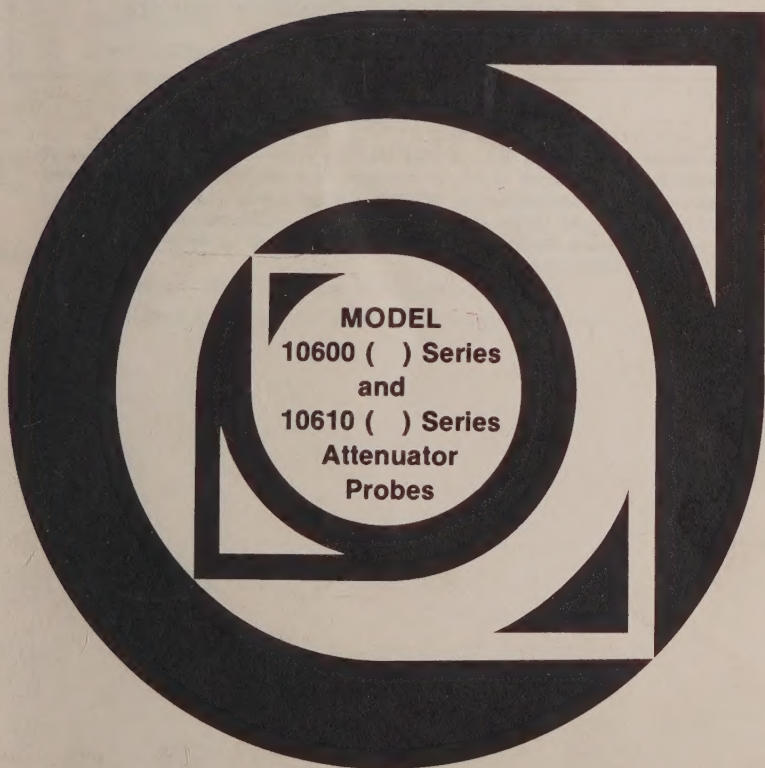


INSTRUCTION MANUAL



Ballantine



MODEL
10600 () Series
and
10610 () Series
Attenuator
Probes

WARRANTY

This Ballantine Laboratories, Inc. product is warranted against defects in materials and workmanship for a period of one year from the date of shipment, except for batteries, electron tubes, vacuum thermocouples, and certain other components, if any, listed in this manual. Ballantine Laboratories, Inc. will, at its option, repair or replace products which prove to be defective during the warranty period provided they are returned to Ballantine Laboratories, Inc. prepaid, and provided the proper preventive maintenance and calibration procedures as listed in this manual have been followed. Repairs necessitated by misuse of the product are not covered by this warranty. NO OTHER WARRANTIES ARE EXPRESSED OR IMPLIED, INCLUDING BUT NOT LIMITED TO THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. BALLANTINE LABORATORIES, INC. IS NOT LIABLE FOR CONSEQUENTIAL DAMAGES.

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Table of Contents

Paragraph		Page
	Model 10600 Series	
1.	Specifications	2
1.2	Electrical Specifications	2
1.3	Mechanical Specifications	4
1.4	Environmental Specifications	5
2.	Operating Instructions	6
2.4	Using the Probe	7
2.5	Probe Frequency Compensation (Oscilloscope)	8
2.6	Probe Frequency Compensation (Voltmeters)	8

Model 10610 () Series

1.	Specifications	11
1.2	Electrical Specifications	12
1.3	Mechanical Specifications	13
1.4	Environmental Specifications	13
2.	Operation Instructions	15
2.4	Using the Probe	15

List of Illustrations

Number		Page
1.	Ballantine 10600 () Series Attenuatory Probe	1
2.	Waveforms Encountered When Adjusting Attenuator	8

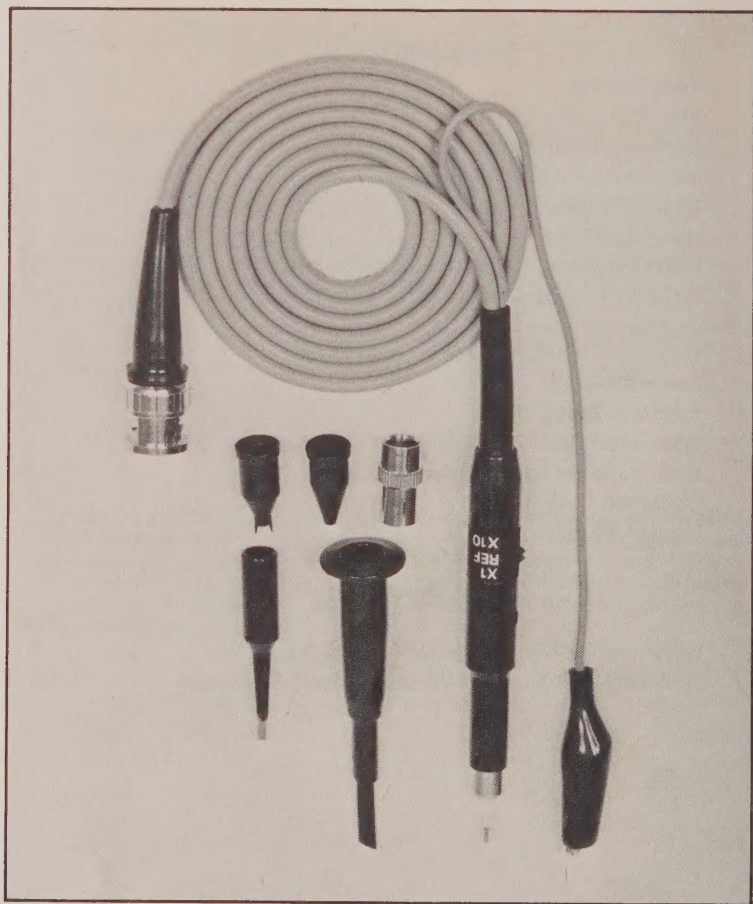


Figure 1. Ballantine 10600 () Series Attenuator Probe

MODEL 10600 SERIES ATTENUATOR PROBE

1. SPECIFICATIONS

1.1 General Description

The Ballantine 10600 Series Probes are small passive ten to one attenuator probes. They are used to provide a high impedance input for oscilloscopes and voltmeters having an input impedance of 1 megohm shunted by 15 to 47 pF.

The 10600 Series Probes feature small diameter bodies to permit their use in compact circuits. The probe tips are built into a Teflon insulator and are sturdy enough to support various accessories by means of push-on adapters. A great number of adapter tips are available and interchangeability and ruggedness are provided by the convenient universal adapter accessory. A BNC adapter is available to permit the probe to mate with standard female BNC connectors in a fully shielded manner.

The probe cables are low capacitance coaxial cables containing a resistive inner conductor to provide optimum transient response. The inner conductor is strain-relieved to assure long cable service life even under field conditions. The probes are terminated in a male BNC connector and three cable lengths are available:

10600D	1 meter (3-1/2 foot)
10601D	2 meters (6 feet)
10602D	4 meters (12 feet)

In addition to the above probes Ballantine offers the 10601C probe which has all the features of the above probes and in addition includes a three position slide switch in the probe body to permit easy selection of X1, GND, REF, and X10 attenuation:

10601C	1.2 meters (4 feet)
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The 10600 Series Probes are frequency compensated with a variable capacitor located in the probe body. Access to this capacitor is provided through a convenient hole in the probe body. Any small insulated screwdriver may be used to adjust the capacitor although a handy adjustment tool is provided with every probe kit.

1.2 ELECTRICAL SPECIFICATIONS

1.2.1 Rise Time

The rise time of the probe is specified when driven from a 25 ohm source and when loaded by a shunt capacity of less than 21 pF.

<u>Probe</u>	<u>Attenuation</u>	<u>Rise Time</u>
10601C	X10	<4 nanoseconds
	X1	<20 nanoseconds
10600D		<6.5 nanoseconds
10601D		<10 nanoseconds
10602D		<20 nanoseconds

1.2.2 Probe Input Capacitance and Input Resistance

The input capacitance at the probe tip is measured at 1 megahertz when the compensated probe is connected to an instrument with 20 pf input capacity. The input resistance is measured when the probe is connected to an instrument with 1 megohm input resistance.

<u>Probe</u>	<u>Input Capacitance</u>	<u>Input Resistance</u>
10601C		
X10	10 pF	10 M Ω
X1	60 pF	1 M Ω
10600D	8 pF	10 M Ω
10601D	9 pF	10 M Ω
10602D	13 pF	10 M Ω

1.2.3 Attenuation

The probes having X10 attenuation are used with oscilloscopes having 1 megohm ($\pm 1\%$) input resistance. The attenuation factor is measured at 1 kHz (sine wave) and is accurate to $\pm 1.5\%$. The probe resistance is 9 megohms $\pm 1.25\%$ at dc and 1 kHz.

The 10601C in the X1 position has no attenuation at dc and low frequencies and is usable beyond 15 MHz.

1.2.4 Compensation Range

The probes may be frequency compensated when capacitively loaded by 15 pF or less to 47 pF or more and with load resistance of 1 megohm $\pm 1\%$.

1.2.5 Bandwidth

The probe bandwidth is measured with oscilloscopes having a bandwidth equal to or greater than 150 MHz. The driving point source impedance must be no greater than 25 ohms.

<u>Probe</u>	<u>Attenuation</u>	<u>Bandwidth</u>
10601C	X10	dc to 80 MHz
	X1	dc to 15 MHz
10600D		dc to 50 MHz
10601D		dc to 35 MHz
10602D		dc to 18 MHz

1.2.6 Maximum Input Voltage

1.2.6.1 DC: ± 600 Volts

1.2.6.2 AC: (sinusoidal waveshape)

10600 X10 position on all attenuator probes

Probe	Frequency	Maximum Input Voltage	
		47 pF load	20 pF load
10600D	to 3.7 MHz	600 V p-p	600 V p-p
	to 5.8 MHz	350 V p-p	600 V p-p
	to 10 MHz	225 V p-p	350 V p-p
	to 30 MHz	75 V p-p	125 V p-p
	to 50 MHz	50 V p-p	75 V p-p
10601D	to 3.7 MHz	600 V p-p	600 V p-p
10601C	to 7 MHz	350 V p-p	520 V p-p
	to 20 MHz	130 V p-p	175 V p-p
	to 70 MHz	45 V p-p	65 V p-p
10602D	to 1.7 MHz	600 V p-p	600 V p-p
	to 2.5 MHz	400 V p-p	525 V p-p
	to 5 MHz	200 V p-p	250 V p-p
	to 20 MHz	50 V p-p	75 V p-p
	to 50 MHz	25 V p-p	30 V p-p

1.2.6.3 The X1 position of the 10601C probe is limited to 600 V dc plus peak ac with a limitation of 5×10^8 Volt Hertz of peak to peak ac sinewave input.

1.3 MECHANICAL SPECIFICATIONS

1.3.1 Cable Length and Weight

Probe	Length		Weight	
	Meters	Feet	gm	Ounces
10601C	1.2	4	283	10
10600D	1	3.5	270	9.6
10601D	2	6	276	9.8
10602D	4	12	283	10

1.4 ENVIRONMENTAL SPECIFICATIONS

1.4.1 Temperature

Operating — 15°C to +60°C

Storage — 55°C to +75°C

1.4.2 Altitude

Operating: 0 to 5,000 meters (16,000 feet)

Storage: —0 to 16,000 meters (51,000 feet)

1.5.1 Accessories

Accessories provided with the 10600 Series Probe Kits.

	"C"	"D"	"D" MOD 100	"F"
a. Straight tip (incorporated in the probe body)	X	X	X	X
b. Retractable tip accessory	X	X	X	X
c. Hook tip			X	
d. Spring tip			X	
e. Banana tip			X	
f. Two (2) insulated miniature alligator accessories			X	
g. Probe holder			X	
h. 5.5 inch ground lead (separate lead)			X	
i. 12.5 inch ground lead (separate lead)			X	
j. 6 inch captive ground lead	X	X		X
k. Accessory fixture for hook, banana, spring tips or others having 6-32 screw insert				
l. Instruction manual	X	X	X	X
m. BNC adapter sleeve	X	X		X
n. Alignment screwdriver	X	X	X	X
o. Tip insulating hood	X	X	X	
p. I/C lead adapter tip	X	X	X	

Note: 10600 C and D Series Probes are available with other than standard accessories. Subscript MOD 100 provides additional accessories. Subscript F provides only a minimum number of accessories.

Model 1060()D-MOD105 X10 Attenuator Probe

This probe is similar to the 1060()D-MOD100 Probe described in the manual and includes the accessories for the MOD100 listed in paragraph 1.5.1:

The following cable lengths are available:

10600D-MOD105	1 meter (3.5 ft.)
10601D-MOD105	2 meters (6 ft.)

All specifications for the 10600D and 10601D probes listed in the manual apply except:

- a. Probe input resistance is $\pm 0.25\%$ when used with a $1\text{ M}\Omega \pm 0.15\%$ input; within $\pm 0.4\%$ with a $1\text{ M}\Omega \pm 2\%$ input.
- b. The BNC connector incorporates a special grounding clip which changes the deflection factor indicator on Tektronix 5000 Series Oscilloscopes to 10X normal reading. The BNC connector is compatible with all standard BNC connectors.

2. OPERATING INSTRUCTIONS

2.1 Remove the probe from its shipping container and attach the ground lead of the desired length. Use the tip provided or attach the retractile tip accessory or accessory holding fixture as required. Simply slip the plastic sleeve of the accessories over the probe body and push together until the probe tip firmly engages the clamp in the accessory. To remove the accessory, just pull it apart from the probe body.

2.2 Probe Grounding

A passive attenuator probe is a resistive divider at dc and low frequencies. It is a capacitive divider at high frequencies. The ground lead may form a significant part of the measurement circuit and may produce a "resonance ring" if driven from signals having sharp spikes or other high frequency components. These "ring" oscillations may appear on the oscilloscope display and may distort the waveform being observed. Ground leads and probe tips should always be kept as short as possible to reduce possibilities of "ringing".

The Ballantine 10600 Series Kit provides a BNC connector adapter sleeve. This accessory may be slipped onto the probe body at its tip. The tip is sized to mate with the inner conductor female sleeve of BNC connectors so that the probe may then be connected directly into BNC female connectors with minimum ground lead and optimum shielding.

2.3 Maximum Input Voltage

Never exceed to maximum input voltage specified above.

This voltage is 600 volts $\pm$ (dc + peak ac) at low frequencies. At higher frequencies the above specified limits must not be exceeded or the probe may be damaged. (See para. 1.2.6.)

2.4 USING THE PROBE

- a. An attenuator probe reduces both the capacitive and resistive loading caused by the oscilloscope or voltmeter. The probe isolates the oscilloscope from the signal source, but reduces the effective sensitivity of the instrument. In other words, the displayed waveform will be reduced in amplitude by the attenuation factor of the probe. The attenuation introduced by the probe permits measurement of signal voltages in excess of those which may be accommodated by the instrument.
- b. When using a probe to sample signals from a tuned, matched, or otherwise critical circuit, capacitive loading by the probe may cause erroneous readings. In these cases it may be necessary to add capacity and resistance to the circuit under observation when the probe is not used. These values should equal that of the probe impedance. This substitution will equalize loading and restore the operating characteristics of the circuit under observation to the same conditions when probe measurements were made.
- c. When using the attenuator probe to make amplitude measurements, multiply the observed amplitude of the display by attenuation factor of 10:1.

IMPORTANT: Before using the probe, always check its frequency compensation adjustment.

- d. An adjustable capacitor in the probe body compensates for variations in input capacitances from one instrument to another. To insure accuracy in pulse transient and ac amplitude measurements, check the probe adjustment frequently.
- e. To preserve the waveform of the signal being displayed, clip the probe ground lead to the chassis of the equipment being tested. Select a short, clean ground point near the probe input connection.
- f. These probes may be connected directly to input BNC connectors on the oscilloscope. The Ballantine 12616A Shielded Terminal Adapter (scope double banana plug to BNC female connector) is required when the probe is connected to binding posts on the oscilloscope or voltmeter. Use the Ballantine 12615A shielded double banana plug to BNC female connector to adapt the 10600 Series Probes to instruments having 10 megohm input resistance.
- g. The 10601C probe features switch selectable attenuation. Simply set the slide switch in the probe body to X1 or X10 for the appropriate attenuation and input impedance. A mid position on the switch provides a REF position for ground reference checks. The REF mode grounds the input of the instruments and grounds the probe tip through a 9 megohm resistor.

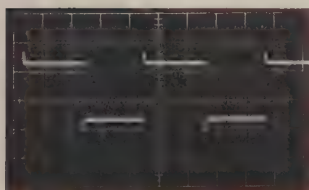
2.5 PROBE FREQUENCY COMPENSATION (OSCILLOSCOPE)

The adjustable mechanical capacitor in the probe body assembly must be adjusted for variations in input capacity for the particular oscilloscope with which the probe is to be used. To adjust the probe, proceed as follows:

- Connect the probe to the input of the oscilloscope.
- Set the oscilloscope attenuator for zero attenuation (maximum sensitivity).
- Apply a fast rise ($<30 \mu\text{sec}$) square wave signal to the probe.
- Adjust capacitor in the probe termination with a narrow bladed insulated screwdriver until the best possible square wave response is obtained as shown in Figure 2.



a. Proper Adjustment of Probe Compensating Capacitor



b. Over Compensated



c. Under Compensated

Figure 2. Waveforms Encountered When Adjusting Attenuator

NOTE: When using Ballantine Oscilloscopes, the output from the front panel CAL jack may be applied to the probe for adjusting its compensation. Refer to the appropriate instruction manual for details.

2.6 PROBE FREQUENCY COMPENSATION (VOLTMETERS)

Required Test Equipment

- A stable low frequency clean sine wave source 1 to 10 volts RMS less than 1% waveform distortion. Low output impedance $<2500 \Omega$. Frequency 50, or 60, or 400, or 1000 Hz.

The Balantine 421A or 421B Voltage Calibrator or the HP 745A or Fluke 5200 ac calibrators are recommended.

- A stable high frequency source at 100 kHz or 1 MHz. Distortion less than 1%. Output impedance 50 ohms or less. The above ac calibrators or the HP 651 oscillator are recommended.

AC wideband voltmeters having high input impedance often require a test probe to minimize loading on the circuit under test and to connect it to the instrument. Attenuator probes are also used to extend the permissible peak voltage to be measured to a maximum of 2000 volts.

The probe should not alter the accuracy or the frequency response of the voltmeter. The probe therefore requires frequency compensation as well as correctional data for the instrument to which it is attached.

The probe is to be matched to a single voltmeter attenuator range but can be used with all applicable attenuation ranges of the voltmeter if the input impedance of the voltmeter is accurately equalized on all attenuator ranges.

Probe Compensation Procedure (Voltmeters)

Step One — Low Frequency Attenuation and Tracking Check

Connect the voltmeter (to which the attenuator probe is to be attached) to the low frequency sine wave source. Set the source to 400 Hz; 50 Hz or 60 Hz line frequency may also be used if the voltmeter is usable at these frequencies.

Set the voltmeter input attenuator to the range covering the voltage to be measured when the probe is installed.

Apply a voltage to the voltmeter which gives 90% of Full Scale reading and note the exact reading.

Next attach the probe to the voltmeter and connect it to the sine wave source instead of the previous direct connection.

Increase the sensitivity of the voltmeter by the probe attenuation factor[†] (by reducing the voltmeter input attenuation). Keep the signal source amplitude constant.

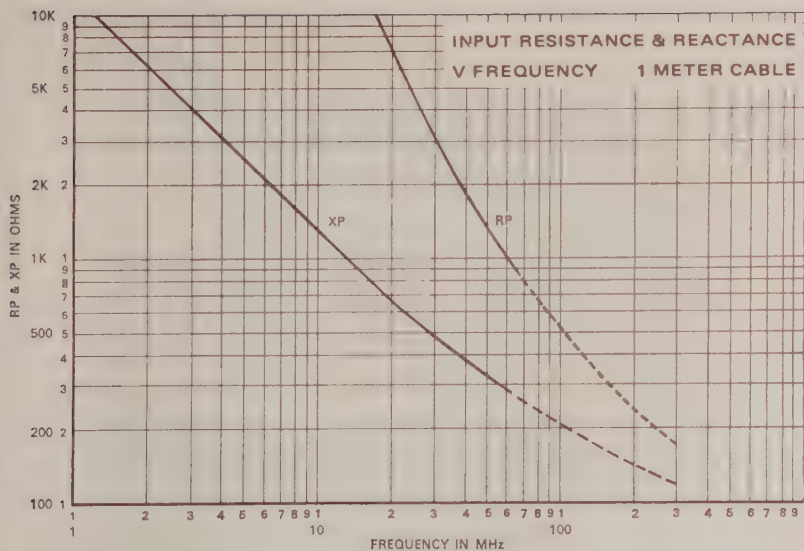
Now read the voltmeter and record the value. It should not vary more than $\pm (3\% + \text{voltmeter attenuator accuracy})$ from the previously recorded direct measurement when all attenuators and probe resistors are in specification since capacitive compensations are usually not active below 400 Hz.

Step Two — High Frequency Normalization

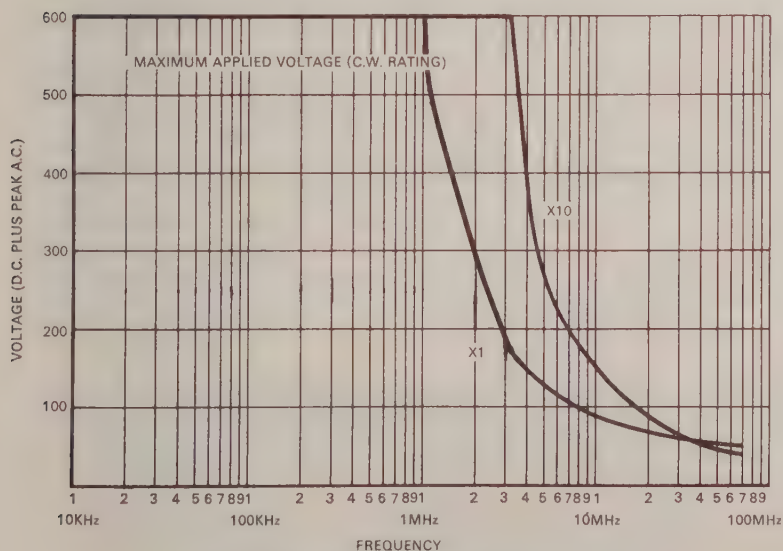
Repeat the above steps using a 100 kHz or 1 MHz sine wave source.

When using the attenuator probe, the voltmeter readings will at first not read the same at high frequencies on the next voltmeter range (increased sensitivity) since the probe has not been compensated.

Next turn the adjustment capacitor in the probe termination until the voltmeter reads exactly the same value previously recorded when not using the probe.



**Input R_p and X_p of 3-1/2 foot probes
Model 10601D**



**Voltage rating of X1 and X10 probe
Model 10601C**

MODEL 10610 SERIES X1 ATTENUATOR PROBE

1. SPECIFICATIONS

1.1 General Description

The Ballantine 10610 Series Probes are small passive X1 attenuator probes. They are used to provide shielded input for oscilloscopes and voltmeters having an input impedance of 1 megohm shunted by 15 to 55 pF.

The 10610 Series Probes feature small diameter bodies to permit their use in compact circuits. The probe tips are built into an insulator and are sturdy enough to support various accessories by means of push-on adapters. A great number of adapter tips are available and interchangeability and ruggedness are provided by the convenient universal adapter accessory. A BNC adapter is available to permit the probe to mate with standard female BNC connectors in a fully shielded manner.

The probe cables are low capacitance coaxial cables containing a resistive inner conductor to provide optimum transient response. The inner conductor is strain-relieved to assure long cable service life even under field conditions. The probes are terminated in a male BNC connector and three lengths are available:

10610D	1 meter	(39.6 inches)
10611D	2 meters	(79.2 inches)
10612D	3 meters	(118.8 inches)

In addition to the above probes Ballantine offers the 10601C probe which has all the features of the above probes and in addition includes a three position slide switch in the probe body to permit easy selection of X1, GND.REF, and X10 attenuation:

10601C	1.2 meters	(4 feet)
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1.2 ELECTRICAL SPECIFICATIONS

1.2.1 Rise Time

The rise time of the probe is specified when driven from a 50 ohm source and when loaded by a shunt capacity of less than 27 pF.

Probe	Rise Time with 50 MHz scope, 100 MHz scope	
10610D	14 ns	14 ns
10611D	25 ns	23.3 ns
10612D	43.7 ns	43.7 ns

1.2.2 Probe Input Capacitance and Input Resistance

The input capacitance at the probe tip is measured when the probe is not connected to any instrument. The input resistance is measured when the probe is connected to a digital multimeter ohmmeter.

Probe	Normal Input Capacitance	Maximum Series Resistance
10610D	32 pF	300 ohm
10611D	54 pF	400 ohm
10612D	78 pF	500 ohm

1.2.3 Attenuation

The 10610D series X1 attenuation probes have $1 \pm 2\%$ attenuation at 1 KHz.

1.2.4 Bandwidth

The probe bandwidth is measured with oscilloscopes having a bandwidth equal to or greater than 100 MHz. The driving point source impedance must be no greater than 50 ohms.

Probe	Bandwidth (100 MHz scope – 3 dB)
10610D	dc to 35 MHz
10611D	dc to 15 MHz
10612D	dc to 8 MHz

1.2.5 Maximum Input Voltage

1.2.5.1 DC: ± 500 Volts (dc + peak ac)

1.2.5.2 AC: (sinusoidal waveshape) in volts RMS

Probe	Frequency	Maximum Input Voltage	
		47 pF load	20 pF load
10610D	dc to 1 MHz	380	380
	1 MHz to 10 MHz	380 linear to 50	380 to 50
	10 MHz to 50 MHz	50 linear to 20	50 to 20
10611D	dc to 300 KHz	380	380
10612D	dc to 500 KHz	350	380
	500 KHz to 10 MHz	350 to 30	350 to 30
	10 MHz to 30 MHz	30 to 18	30 to 18

1.3 MECHANICAL SPECIFICATIONS

1.3.1 Length and Weight

Probe	Length		Weight	
	Meters	Inches	gm	Ounces
10610D	1	39.6	165	6
10611D	2	79.2	165	6
10512D	3	118.8	165	6

1.4 ENVIRONMENTAL SPECIFICATIONS

1.4.1 Temperature

Operating — 15°C to $+60^{\circ}\text{C}$

Storage — 55°C to $+75^{\circ}\text{C}$

1.4.2 Altitude

Operating: 0 to 5,000 meters (16,000 feet)

Storage: —0 to 16,000 meters (51,000 feet)

1.5.1 Accessories

Accessories provided with the 10610 Series Probe Kits.

Accessories	"D"	"M"	"F"	"D" MOD 110
a. Straight tip (incorporated in the probe body)	X	X	X	X
b. Retractable tip accessory	X	X		X
c. Hook tip		X		X
d. Spring tip		X		X
e. Banana tip		X		X
f. Two (2) insulated miniature alligator accessories		X		(1)
g. Probe holder		X		
h. 5 inch ground lead (separate lead)		X		X
i. 12 inch ground lead (separate lead)		X		X
j. 6 inch captive ground lead	X		X	
k. 3 inch ground lead				X
l. Accessory fixture for hook, banana, spring tips or others having 6-32 screw insert		X		
m. Instruction manual	X	X	X	X
n. BNC adapter sleeve	X	X		X
o. Tip insulating hood	X			X
p. I/C lead adapter tip	X			

Note: 10600C and D Series Probes are available with other than standard accessories. Subscript M provides additional accessories. Subscript F provides only a minimum number of accessories.

2. OPERATING INSTRUCTIONS

2.1 Remove the probe from its shipping container and attach the ground lead of the desired length. Use the tip provided or attach the retractile tip accessory. Simply slip the plastic sleeve of the accessories over the probe body and push together until the probe tip firmly engages the clamp in the accessory. To remove the accessory, just pull it apart from the probe body.

2.2 Probe Grounding

A passive X1 attenuator probe is a resistive load at dc and low frequencies. It is a capacitive load at high frequencies. The ground lead may form a significant part of the measurement circuit and may produce a "resonance ring" if driven from signals having sharp spikes or other high frequency components. These "ring" oscillations may appear on the oscilloscope display and may distort the waveform being observed. Ground leads and probe tips should always be kept as short as possible to reduce possibilities of "ringing".

The Ballantine 10610 Series Kit provides a BNC connector adapter sleeve. This accessory may be slipped onto the probe body at its tip. The tip is sized to mate with the inner conductor female sleeve of BNC connectors so that the probe may then be connected directly into BNC female connectors with minimum ground lead and optimum shielding.

2.3 Maximum Input Voltage

Never exceed the maximum input voltage specified above.

This voltage is 500 volts ($\pm$ dc + peak to peak ac) at low frequencies. At higher frequencies the above specified limits must not be exceeded or the probe may be damaged.

2.4 USING THE PROBE

- a. When using a probe to sample signals from a tuned, matched, or otherwise critical circuit, capacitive loading by the probe may cause erroneous readings. In these cases it may be necessary to add capacity and resistance to the circuit under observation when the probe is not used. These values should equal that of the probe impedance. This substitution will equalize loading and restore the operating characteristics of the circuit under observation to the same conditions when probe measurements were made.
- b. To preserve the waveform of the signal being displayed, clip the probe ground lead to the chassis of the equipment being tested. Select a short, clean ground point near the probe input connection. If possible, use the BNC adapter without the ground lead.
- c. These probes may be connected directly to input BNC connectors on the oscilloscope. The Ballantine 12616A Shielded Terminal Adapter (scope double banana plug to BNC female connector) is required when the probe is connected to binding posts on the oscilloscope or voltmeter.

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